

REMARKS

Introduction

Claims 1, 3-22 remain in this application. Claims 1 and 3-22 have been amended. Claim 2 has been canceled. Claim 23 has been added.

Claim Rejections Under 35 U.S.C. § 112

The rejection of claims 1-22 under 35 U.S.C. 112, second paragraph, as being indefinite as contended by the Examiner has been addressed.

Applicants have amended claim 1 to remove "carbon nanotube-polymer composite," which was not intended to be limiting but merely a descriptive name for the claimed apparatus. Claims 3-22 have also been amended to reflect this change.

Applicants have amended claim 3 to clearly state that the weight percent of single wall carbon nanotubes refers to their weight percent in the nanotube-polymer composite.

Applicants have amended claim 19 to replace "electrochemical" with "electromechanical", as suggested by the Examiner. Claim 19 now has proper antecedent basis and therefore is in allowable form.

With respect to other claims dependent upon claim 1, claim 1 is now in allowable form and therefore the claims dependent on claim 1 are in allowable form.

For the foregoing reasons, claim 1, claim 3, claim 19, and other claims are in allowable form and should be examined for patentability.

Claim Rejections Under 35 U.S.C. § 102

The rejection of claims 1-4, 6-13, and 15-22 under 35 U.S.C. 102(b) as being anticipated by the *Baughman* patent (US 6,555,945) as contended by the Examiner has been addressed.

Baughman teaches actuators based on electrochemical double-layer induced charge injection in materials having very high specific surface areas. Baughman uses non-faradaic charging of an extremely high surface area material as an electrode.

Applicants teach actuators having at least one electrode comprising a **carbon nanotube-polymer composite doped with a metal**. Applicants teach the benefits of composites formed from carbon nanotubes and polymers including increased load transfer and increased thermal conductivity. The list of polymers that Applicants teach includes Nafion®, ionomers, polyelectrolytes, smart gels, aerogels, copolymers, block polymers, straight chain polymers, protein complexes, and others. Applicants teach doping the carbon nanotube-polymer composites with metals such as gold, platinum, copper, and combinations thereof.

Applicants teach novel variations of the carbon nanotube-polymer composite actuators such as the effective weight percent of nanotubes in the carbon nanotube-polymer composite, the use of monovalent metal ions, polyvalent metal ions, and combinations thereof as electrolytes, the method of using the actuator in aqueous, non-aqueous, gel, or solution free environments, the inclusion of an osmotic mechanism in the actuator's electromechanical response, the application of a surfactant to the actuator, and the use of a ceramic electrode in the actuator.

Applicants teach a unique method of producing the carbon nanotube-polymer composite. This process comprises preparing a carbon nanotube-polymer solution, casting the solution to form a composite, drying the composite, and doping the composite with a metal. Applicants also teach additional features of this process such as the use of alcohol in the preparation of the carbon nanotube-polymer solution, the high shear stirring of the carbon nanotube-polymer solution before casting, the homogenization of the carbon nanotube-polymer

solution before casting, and the centrifuging of the carbon nanotube-polymer solution before casting.

Claim 1 has been amended to further include the feature of *"at least one electrode comprising a carbon nanotube-polymer composite doped with a metal."* Applicants' research has shown that doping the carbon nanotube-polymer composite actuators improves the performance of the actuators by increasing their displacement capabilities. See page 26 of Applicants' specification, lines 3-13. "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." MPEP §2131 citing *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). Metal doping of the actuator is not taught by Baughman and can therefore not be anticipated by Baughman. Since all features of newly amended claim 1 are neither taught nor suggested by Baughman, newly amended claim 1 is allowable in view of Baughman. Furthermore, the Examiner indicated, via a voicemail left on July 18, 2007, that a reference having a nanotube-polymer composite doped with a metal could not be found. Therefore, newly amended claim 1 should be allowed.

Claim 2 has been canceled.

With respect to claims 4, 6, and 11-13: Claim 4 is dependent on claim 1, which for the foregoing reasons is allowable.

Claims 6 and 11-13 are dependent on claim 5, which was not rejected by the Examiner. Since claims 6 and 11-13 are dependent upon allowable claim 5, claims 6 and 11-13 are allowable. Furthermore, Applicants respectfully disagree with the Examiner's assertion that claims 11-13 are invalid as product-by-process claims. The Examiner suggests that Baughman teaches that how the carbon nanotube-polymer composite is formed does not affect the

resulting electrode of the actuator. Applicants assert that the carbon nanotube-polymer composite taught by Baughman is not the same carbon nanotube-polymer composite that Applicants teach. The "*high shear stirring*," "*homogenization*," and "*centrifugation*" improve the performance of the actuator by creating a more uniform carbon nanotube-polymer composite with increased purity as described in page 18 of Applicants' specification, lines 19-23.

Applicants have found that an increased homogeneous distribution of nanotubes in the polymer results in better percolation thresholds for electronic and thermal conductivity. See page 19 of Applicants' specification, lines 15-17. Applicants have added the additional feature in claim 1 of metal doping of the carbon nanotube-polymer composites. Even if claims 11-13 are product-by-process claims, the product produced by the process claimed by Applicants is materially and structurally different from Baughman.

With respect to claims 11-13, Applicants respectfully disagree with the Examiner's assertion that claims 11-13 are anticipated by Baughman. The paragraph bridging Baughman columns 28-29 teaches a process of coating optical fibers with carbon nanotubes by depositing the nanotubes from a mixture of nanotubes and electrolyte polymer contained in a volatilized liquid. The paragraph also teaches the use of a nanotube assembly that is immersed in a liquid electrolyte. Baughman makes no reference to the "*high shear stirring*" in claim 11, the "*homogenization*" in claim 12, or the "*centrifuging*" in claim 13 of the carbon nanotube-polymer solution, the processes taught by Applicants in pages 20-21 of the specification. "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." MPEP §2131 citing *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).

Because the processes of claims 11-13 are not taught by Baughman, they cannot be anticipated by Baughman.

Claim 7 is dependent on claim 5, which was not rejected by the Examiner. Since claim 7 is dependent upon allowable claim 5, claim 7 is allowable.

Claim 8 is dependent on claim 5, which was not rejected by the Examiner. Since claim 8 is dependent upon allowable claim 5, claim 8 is allowable.

Claim 9 is dependent on claim 5, which was not rejected by the Examiner. Since claim 9 is dependent upon allowable claim 5, claim 9 is allowable.

With respect to claim 15, Applicants respectfully disagree with the Examiner's assertion that claim 15 is anticipated by Baughman. Applicants are unable to locate any reference to polyvalent metal ions used as electrolytes in the paragraph bridging Baughman columns 17 and 18. "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." MPEP §2131 citing *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). Since Baughman does not teach the use of polyvalent metal ions or combinations of monovalent and polyvalent metal ions as electrolytes as claimed by Applicants, claim 15 is allowable in view of Baughman.

Claim 16 is dependent on claim 5, which was not rejected by the Examiner. Since claim 16 is dependent upon allowable claim 5, claim 16 is allowable.

Claim 17 is dependent on claim 5, which was not rejected by the Examiner. Since claim 17 is dependent upon allowable claim 5, claim 17 is allowable.

With respect to claims 18-19: Claim 18 is dependent on claim 5, which was not rejected by the Examiner. Since claim 18 is dependent upon allowable claim 5, claim 18 is allowable.

With respect to claim 19, Applicants respectfully disagree with the Examiner's assertion that claim 19 is anticipated by Baughman. Baughman col. 4, lines 8-17 and col. 5, lines 47-59 are directed to the functions of the Baughman actuators. Baughman teaches the conversion of electrical energy to actuator output and conversion of mechanical energy to electrical energy. Applicants teach the conversion of osmotic processes into electrical energy, which is not taught or suggested by Baughman. "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." MPEP §2131 citing *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). Because Baughman does not teach the use and conversion of osmotic processes, Applicants' claim 19 is allowable in view of Baughman.

With respect to claims 20-22: Applicants respectfully disagree with the Examiner's assertion that claims 20 and 21 are anticipated by Baughman. Baughman col. 7, lines 5-45 contains a detailed description of Baughman Figures 1 and 2, which illustrate charge injection for a non-faradaic electromechanical actuator based on non-bundled (isolated) carbon single-wall nanotubes and charge injection for a bundled array of single-wall carbon nanotubes, respectively. Baughman claim 74 teaches an electromechanical microactuator with a working electrode, a counter electrode, and an electronically insulating electrolyte. Baughman claim 75 teaches the microactuator of claim 74 with at least one carbon nanotube electrode. Baughman claim 76 teaches the microactuator of claim 75 where the carbon nanotube is a single-wall carbon nanotube. Baughman claim 77 teaches the microactuator of claim 74 where the second electrode has a total surface area at least 100 times larger than the surface area of the first electrode.

Applicants teach a carbon nanotube-polymer composite electrode having an applied surfactant in claim 20 and a carbon nanotube-polymer composite electrode where at least one electrode is ceramic in claim 21. There is no reference to "*applied surfactants*" or the use of "*ceramic electrodes*" in Baughman col. 7, lines 5-45, claims 74-77, or anywhere else in the Baughman patent. As referenced earlier, "a claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." MPEP §2131 citing *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). Because Baughman does not contain the elements of applying surfactants to actuators or using ceramic electrodes, claims 20 and 21 are not anticipated.

Claim 22 is dependent on claim 1, which for the foregoing reasons is allowable.

Claims 3 and 10 were included in the Examiner's list of claims rejected under 35 U.S.C. 102(b) as being anticipated by Baughman but were not discussed by Examiner. MPEP §707.07(d) states that for any claim rejection, the Examiner must "fully and clearly" state the grounds for rejection. Applicants contend that the Examiner has not "fully and clearly" stated the grounds for rejecting claims 3 and 10 and has failed to make any showing that claims 3 and 10 are anticipated by Baughman. As such, Applicants submit that claims 3 and 10 are not anticipated by Baughman are allowable.

Claim Rejections Under 35 U.S.C. § 103

The rejection of claim 3 under 35 U.S.C. 103(a) as being unpatentable over *Baughman '945* (6,555,945) as contended by the Examiner has been addressed.

The Examiner states that it would have been obvious through routine experimentation to a person having ordinary skill in the art to arrive at the amount of single wall carbon nanotubes

in the composite as claimed. Applicants respectfully disagree. This range of possible weight percentages is important because there is a physical limit on the amount of nanotubes that can be dispersed in a polymer and still provide a useful composite. Development of practical applications for single-walled nanotube-polymer composites is dependent on homogenous dispersions of the nanotubes in the polymer, whether for load transfer from polymer matrix to the single-walled nanotubes or percolation networks by the single-walled nanotubes responsible for electrically conductive pathways. See page 11 of Applicants' specification, lines 11-15. Applicants teach various polymer matrices for composite dispersions with single-walled nanotubes at varying percents by weight.

Applicants contend that the weight percent of nanotubes in the nanotube-polymer composite is not a result-effective variable. MPEP §2144.05 II(B) states that "a particular parameter must first be recognized as a result-effective variable, i.e., a variable which achieves a recognized result, before the determination of the optimum or workable ranges of said variable might be characterized as routine experimentation." MPEP §2144.05 II(B) citing *In re Antonie*, 559 F.2d 618, 195 USPQ 6 (CCPA 1977). Thus, the optimization of a variable that is not result-effective is a non-obvious discovery. The prior art does not indicate that the weight percent of nanotubes in the nanotube-polymer composite is a result-effective variable. As such, Applicants' discovery is not obvious.

Furthermore, Applicants respectfully submit that the Examiner is attempting to classify the range claimed in claim 3 as "obvious to try." MPEP §2145(X)(B) states that an "obvious to try" rationale is an improper rationale for support of a claim rejection under 35 U.S.C. 103. "The admonition that 'obvious to try' is not the standard under § 103 has been directed mainly at two kinds of error. In some cases, what would have been 'obvious to try' would have been to vary all

parameters or try each of numerous possible choices until one possibly arrived at a successful result, where the prior art gave either no indication of which parameters were critical or no direction as to which of many possible choices is likely to be successful.... In others, what was 'obvious to try' was to explore a new technology or general approach that seemed to be a promising field of experimentation, where the prior art gave only general guidance as to the particular form of the claimed invention or how to achieve it." MPEP §2145(X)(B) citing *In re O'Farrell*, 853 F.2d 894, 903, 7 USPQ2d 1673, 1681 (Fed. Cir. 1988) (citations omitted). Applicants have specified an exact range for a variable that produces optimal results. This discovery could have been made by routine experimentation, but this ignores the importance of the discovery and is contrary to the language of §103. Therefore, claim 3 is allowable in view of Baughman and should be allowed.

Claims not Addressed under 35 U.S.C. 102 or 103

Claim 5 has been rewritten in independent form. As the Examiner did not reject claim 5, this claim should be allowed. Furthermore, the Examiner indicated, via a voicemail left on July 18, 2007, that claim 5 was not rejected because a reference having a nanotube-polymer composite doped with a metal could not be found. Therefore, new independent claim 5 should be allowed.

Claim 14 is dependent on claim 5, which was not rejected by the Examiner. Since claim 14 is dependent upon allowable claim 5, claim 14 should be allowed. Furthermore, the Examiner indicated, via a voicemail left on July 18, 2007, that claim 14 was not rejected because a reference having a nanotube-polymer composite doped with a metal could not be found. Therefore, newly amended claim 14 should be allowed.

New Claim

Applicants have added dependent claim 23 in response to the voicemail left by the Examiner on July 18, 2007. The Examiner raised a possible objection to the inclusion of "smart gels" in claim 8 as being indefinite. Applicants respectfully submit that "smart gels" refers to a class of materials that was known in the art at the time of filing and a person having ordinary skill in the art would be enabled by the term "smart gels." See U.S. Patent 6,538,089.

Conclusion

For the foregoing reasons, Applicants respectfully request that the Examiner allow Amended claims 1 and 3-22, and newly added claim 23 as indicated on the attached complete listing of claims.

Respectfully submitted,

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Attachment

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